

## Introduction

Sorghum grows well in arid and semi-arid agroecological zones and is thus one of the most important cereals in the Sahel region of Sub-Saharan Africa (SSA).<sup>3</sup> Sudan, Burkina Faso, Mali, Nigeria, and Niger lead sorghum production per capita in SSA. Per capita consumption is dominated by Sudan, Burkina Faso, Mali, and Chad. Ethiopia is also a major producer and consumer of sorghum.<sup>4</sup> FAO data from 2006 show that African sorghum exports totaled just under 20,000 tons, yet sorghum imports totaled 921,000 tons, indicating that SSA countries produce mostly for internal consumption, and when importing, use sources outside of SSA.<sup>5</sup>

Sorghum production provides both nutrition and cultivation benefits to SSA households. Nutritionally, the higher levels of iron and zinc found in sorghum can help mitigate malnutrition in children.<sup>6</sup> In terms of cultivation, sorghum yields increase with fertilizer use and timely weeding. Sorghum, however, is susceptible to cultivation threats like the parasitic weed striga, anthracnose, bird attacks, and spotted stem borers. Despite these cultivation challenges, sorghum remains an important food source for much of the Sahel.<sup>7</sup>

Because sorghum is grown primarily for household food consumption in SSA, it is typically thought of as a woman's crop. However, in some settings it is difficult to define sorghum as either a women's or men's crop. In Ghana, Doss found that sorghum tended to be grown disproportionately in plots owned by men, which in Ghana meant defining sorghum as a men's crop. However, sorghum was grown primarily in the Savannah region of Ghana, a region with relatively few female-headed households. Thus, what could be interpreted as a "man's crop" could simply be the result of women not

Table 1. Characteristics of Sorghum in SSA

<b>History</b>	Species: <i>Sorghum bicolor</i> Originated in East Africa
<b>Uses</b>	95% of production used for human food; sorghum beer; future use as biofuel stock
<b>Demand</b>	Constant as a staple food- and beer-crop; thought of as economically inferior good; potential for biofuel
<b>Primary Cultivation Challenges</b>	Striga (parasitic weed), drought, spotted stem borer (pest), anthracnose (fungal infection), bird attacks
<b>Current Technology Efforts</b>	Machinery: dehullers, mechanical milling Traits: drought resistance, striga resistance, increased yields, early maturing
<b>Inputs</b>	Fertilizer (particularly nitrogen)
<b>Major Producers<sup>1</sup></b>	Tons/year: Nigeria, Sudan, Ethiopia, Burkina Faso, Niger Tons/capita: Sudan, Burkina Faso, Mali, Nigeria, Niger
<b>Major Consumers<sup>2</sup></b>	Tons/year: Nigeria, Sudan, Ethiopia, Burkina Faso, Mali Kg/person/year: Burkina Faso, Sudan, Chad, Nigeria, Mali

having ownership of land instead growing sorghum on men's land.<sup>8</sup> Evidence from Uganda suggests that though gendered crops are thought to exist, in reality, gender distinctions are never clear. In the case of sorghum, both men and women cultivate primarily for household consumption, though women are nearly exclusively responsible for post-harvest production of the grain, including brewing and selling sorghum beer.

In Mali, Boughton and Reardon (1997) found that the purchase of raw sorghum fell rapidly with increased income, indicating that it is an economically inferior good.<sup>9</sup> Similar patterns are seen in Uganda, where sorghum is regarded as 'poor man's food', or even worse, 'poor woman's food', and excluded from the dietary choices of aspiring middle classes.<sup>10</sup> In fact, over the last 20 years, consumers in SSA have shifted away from traditional coarse grains like sorghum to rice and maize

to save time on post-harvest processing.<sup>11, 12</sup> Research suggest this shift is due more to changes in women's value of time than changes in household income.<sup>11</sup>

### **Improved Varieties**

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is the largest source of sorghum germplasm.<sup>7</sup> ICRISAT's research efforts on improved varieties have focused on improving yields with less attention to improving the quality of the grain.<sup>3</sup> In recent years, ICRISAT scientists have developed early-maturing varieties, midge-resistant varieties, and striga-resistant varieties.<sup>13</sup> Yet improved varieties account for less than 10 percent of SSA's planted sorghum.<sup>7</sup> A potential explanation is that improved varieties usually involve tradeoffs that diminish the value of the crop in the larger farming system scheme and diminish adoption rates. For example, early-maturing varieties released in Ethiopia were not widely adopted, despite their efficacy during drought. Conversations with farmers found that early-maturing varieties were susceptible to bird attacks, and the reduced biomass had less value for livestock use.<sup>7</sup> For Ethiopian farmers, these negative outcomes outweighed the potential yield increases from early maturation.

Involving both men and women farmers in early seed dissemination and testing can lead to better adoption rates. For example, striga-resistant varieties had greater success in Ethiopia because farmers were able to test the varieties and thus better understood the efficacy of the improved seed.<sup>7</sup>

### **Seed Procurement**

Evaluating the mechanisms regarding improved varietal adoption, researchers in Mali found that most of the sorghum seed used in the country was uncertified and traded among farmers. Furthermore, seed vendors were mostly women. Of 100 vendors interviewed, only one vendor sold a modern variety (CSM 63E), despite a government emphasis on liberalizing the formal seed market. It was unclear to researchers whether this lack of modern varieties in the seed market was due to lack of supply or lack of demand.<sup>14</sup> However, the explanation for limited adoption of improved varieties in SSA may be due, in part, to the nature of seed exchange, a system of informal, small-scale trade, managed through networks of women farmers.

Because sorghum is indigenous to SSA, tremendous variety exists among available seed. In Mali, for example, women farmers have accumulated knowledge about seed varieties over thousands of years.<sup>15</sup> Malian custom places a high value on having one's own seed, and to be without carries strong social stigma.<sup>15</sup> In Ethiopia, farmers have an established folk taxonomy to classify their landrace seed (indigenous varieties). The names depend on botanical characteristics, use, agro-ecological traits, and adaptiveness.

Smale et al. (2009) described the seed trade in the San and Douentza areas of Mali:

No certified seed was sold in any of the 12 local markets surveyed. In the informal sector, farmers supply other farmers with noncertified seed through social networks or village grain markets, typically to trustworthy members of their clan and ethno-linguistic group. The quality of this seed is generally considered to be good.

Women in Mali tend to travel a shorter distance than men to procure seed, thus women are more likely to trade seed with farmers from the same village.<sup>15</sup> Women farmers tend to want to grow very specific varieties of sorghum to meet their needs for home consumption and brewing. To be fully utilized, formal seed markets must therefore take the needs and preferences of women into account or women farmers will continue to save their seeds and trade informally.<sup>16</sup>

### **Land Preparation and Soil Fertility**

Because of its ability to withstand drought, farmers in Burkina Faso plant sorghum primarily in rain-fed fields, without the use of irrigation.<sup>17</sup> Not surprisingly, evidence from nine Burkinabe villages showed increased yields with soil and water conservation investments.<sup>18</sup>

In SSA, land is generally prepared by hand due to the small land holdings of farmers and the lack of tractors. Although sorghum lends itself to large-scale monocropping as seen in the United States, most sorghum in SSA is grown on small plots by small-scale farmers.<sup>19</sup> Adhola and Iteso women in Uganda tend to sow their sorghum in mixtures of two to 12 varieties per plot, with an average of nearly three varieties per plot. Yet Ugandan women do not consciously maintain varieties of sorghum for diversity; rather, they base their selections

on specific traits amenable to food preparation and brewing sorghum beer.<sup>10</sup>

### Land Tenure

Women are usually responsible for cultivating food for home consumption on household plots whereas men usually grow the main cash crop on personal plots.<sup>20,21</sup> In many areas, women are also allowed to cultivate and gain income on a personal plot.<sup>20,22</sup> Because sorghum is not often used as a cash crop, women are the primary cultivators. Even though women control most post-harvest production, they typically grow the grain on plots owned or controlled by their husbands. For example, Adhola and Iteso women of Uganda often refer to themselves as “visitors” in their husbands’ land because of their lack of ownership and decision making power over production resources.<sup>10</sup>

Increasing population pressure on the land has led to declining per hectare yields among the Mossi group in Burkina Faso in part due to decreased fallow periods. In addition, yields likely decreased as farmers expanded production onto more marginal land.<sup>22</sup> Women farmers with less access to credit and thus low access to inputs like fertilizer continue to see decreased yields and are at times unable to feed their families solely from household plots.

### **Crop Maintenance**

#### Weeding

Weed control for sorghum begins with the first tilling of the land, which breaks up weed roots that have germinated after the first rain. To maximize yields, weeding is important during the first 45 days, as this is the time when competition for soil nutrients will cause the most harm to the young sorghum plant. However, women farmers are often required to provide labor for other cash crops during this crucial time of weeding for sorghum.<sup>23</sup>

For example, among the Massa farmers in Northern Cameroon, sorghum competes with rice for labor during the period of rice transplanting and sorghum planting and weeding. Evidence from Uganda shows a similar labor conflict between maize and sorghum. During times of labor scarcity, women are expected to prioritize

labor for their husband’s crops (including rice) at the expense of their own.<sup>24</sup> Generally, this means prioritizing maize planting, weeding, and harvesting over sorghum cultivation.<sup>10</sup> Sorghum yields will thus decline with the decreased availability of cultivation labor.

### Inputs

Like most crops, fertilizer use increases sorghum yields. However, women often lack resources to purchase fertilizer, and within households, limited fertilizer is often diverted to cash crops, like maize, away from household crops, like sorghum.<sup>16</sup>

### Labor and Time Demands

Cultivation labor is not always allocated efficiently within a household. Evidence from Cameroon suggests that women use their labor as a bargaining tool to receive more compensation from their husbands,<sup>25</sup> and also to increase their power over production income allocation.<sup>24</sup>

In post-harvest processing of sorghum, women are largely responsible for the threshing, winnowing, drying, husking, shelling, and milling necessary to prepare sorghum for human consumption. These tasks are often arduous, monotonous, and time-consuming, though can be ameliorated using appropriate technology.<sup>19</sup>

### Role of Extension Agents

In the Tigray region of Ethiopia, extension agents played a role in the dissemination of striga-resistant varieties in the early 1990s, however, adoption rates were not high.<sup>26</sup> Researchers conducted a survey of 90 households and found that access to information significantly and positively influenced adoption rates. Thus, to increase the rate of new seed technology adoption, extension agents should include an education component in their service, in addition to the distribution of new seed technologies.<sup>26</sup>

Though not unique to sorghum, extension services which consistently bypass women slow the adoption of new technologies, including improved varieties.<sup>22,27</sup> Extension agents are often men, who may lack sensitivity to women’s time and credit constraints or may ignore women with low levels of formal education, thinking them incompetent.<sup>28</sup> Low education levels are related to

low technology adoption,<sup>29</sup> making gains in girls' education and appropriate agricultural training for women essential.

### **Harvest**

An Ethiopian farmer is quoted as saying, "A man who speaks the truth first is reviled by the audience and a sorghum plant which matures first is taken by birds."<sup>7</sup> Unfortunately, women's time constraints do not often allow for timely harvesting of sorghum, thus significant losses can result from bird attacks. Harvesting is done by hand, usually by women and children. The plant heads are then manually thrashed using cheap, readily available implements like sticks to remove the grain from the plant.<sup>19</sup>

### **Post-Harvest Processing**

Ugandan women plant different sorghum varieties for different post-harvest purposes. For example, women use red sorghum for brewing banana beer, red spear sorghum for *mwenge* beer, and white spear sorghum for their staple porridge dish of *kebalu*.<sup>10</sup> During post-harvest aggregation for market, however, this grain variation is lost because sorghum tends to be bulked together at the first rural assembly stage.<sup>9</sup> Thus, women who desire certain grain characteristics for brewing may have a difficult time finding sorghum grains to fit their needs.

Mechanical processing can save time and energy over the alternative manual grinding using rocks or a mortar and pestle. In Mali, sorghum dehulling is undertaken by retailers using mechanical dehullers meant for paddy rice. Though quicker, the rice huller results in greater dehulling losses than result from the sorghum-appropriate abrasive-disk dehulling.<sup>9</sup> In Botswana, sorghum mills have reduced processing time for 20 kilograms of sorghum from up to four hours to only four minutes. Additionally, evidence suggests that women value the energy savings so much so that they will walk long distances to mechanical processing stations. This suggests that women are more concerned with the energy savings than the time savings.<sup>30</sup>

Mechanical milling can further expedite sorghum processing. In Nigeria, where about 80 percent of sorghum and millet is now mechanically milled into whole flour, over 2.5 million tons of sorghum have been processed in this way.<sup>31</sup>

### **Storage**

In some countries in West Africa sorghum and millet grains are mixed with wood ash and stored in clay pots. In Nigeria specifically, sorghum and millets are stored as unthreshed heads in a solid walled container called a *rumbu*. For short-term storage, bundles of sorghum are arranged in layers in the *rumbu*. Sorghum can be stored in these *rumbus* for up to six years if the heads are laid out individually and not bundled. In Uganda, sorghum is threshed and stored in gunny sacks, whereas in Sudan, grain is stored in underground pits.<sup>31</sup> Sorghum flour quickly turns rancid in the SSA climate. Therefore, most sorghum is stored as the whole grain.<sup>31</sup>

Because most sorghum is consumed by the household or traded in local markets, bulk storage is not often used.<sup>31</sup> However, sorghum's potential as a biofuel may drastically change the scope of grain storage and transportation.

### **Consumption and Sale**

In Mali, evidence suggests that female-headed households tend to purchase less raw sorghum (which requires processing), in large part because of the higher opportunity cost of time. In contrast, however, purchases of processed sorghum rise with income for female-headed households. These findings reaffirm the thinking that women with greater opportunity cost of time will seek to reduce home expenditure of time in cereal processing by purchasing pre-processed grains, or by hiring household help for processing.<sup>9</sup>

Sorghum beer sales are a significant source of income for women in SSA. In Nyankole Parish in eastern Uganda, 66 percent of women surveyed in a small-scale study stated that their income from beer sales made a greater contribution to the household than income from other family members, meaning that it was the largest individual contribution to the household. Sales from sorghum grain, on the other hand, were only a small fraction of women's earnings.<sup>10</sup>

### **Sorghum as Biofuel**

Sweet sorghum has potential as a biofuel stock in the future, though current biofuel production efforts focus more on maize. Opponents of using food crops for fuel point out that it appears difficult for African farmers to produce food and fuel simultaneously. Mersie disagrees, arguing that economic, social, and environmental

benefits of modern bioenergy can be realized through a strategy that centers on smallholder production and processing schemes and pursuit of a livelihood approach to energy development.<sup>32</sup>

As has been shown with crops like rice, as production shifts from household consumption to cash-crop production, men tend to takeover production.<sup>33,34</sup> This is especially true, if women do not have usufruct rights to land that might be converted to biofuel crops, since women are unlikely to convert their smaller, household plots to biofuels and risk household food security. Thus, if women are to reap the benefits of increased sorghum demand from biofuel production, policies or programs must be in place to mitigate that risk.

## **Conclusion**

Improved sorghum varieties have the potential to greatly increase sorghum yields in SSA by alleviating cultivation threats from striga, pests, and drought. Because women farmers are the primary cultivators of sorghum, they stand to benefit most from these improved varieties. However, low adoption rates of new technologies suggest that more resources need to be dedicated to extension efforts and informal seed distribution networks that include women farmers. Post-harvest processing of sorghum is both time and labor intensive and is causing many women farmers to transition to maize or rice. Finally, increased demand for sorghum as a biofuel stock may not translate into gains for women farmers as expected, because women farmers tend to lack input resources, and women farmers often lose control over crops as they transition to cash crops.

## Endnotes

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